

App. No. 10/666,189
Amendment dated July 11, 2005
Reply to Office Action mailed May. 26, 2005

Docket No. QNX001

IN THE CLAIMS:

Claims 1-51 are cancelled.

Claims 52-73, 75-90, and 92-99 are in this application.

Claims 74 and 91 are cancelled.

Claim 98 and 99 have been added.

Claims 52-57, 62, 66 68, 69-72, 75-89, and 92-97 are amended as set forth below

52. (Amended) A liquid cooling system for cooling heat-generating components in an electronic system having no reservoir and comprising:

a heat exchange unit for receiving heated liquid and generating cooled liquid in the reservoirless liquid cooling system;

one or more heat transfer units coupled to the heat generating components for receiving cooled liquid from the heat exchange unit and generating heated liquid for transportation to the heat exchange unit in the reservoirless liquid cooling system; and

means for transporting cooled liquid from the heat exchange unit to the heat transfer units and for transporting heated liquid from the heat transfer units to the heat exchange unit in the reservoirless liquid cooling system.

53. (Amended) A liquid cooling system for cooling heat-generating components in an electronic system having a self-contained heat exchange unit installable as a single unit within the electronic system and comprising:

[a heat exchange unit for receiving heated liquid and generating cooled liquid;]

an input cavity for receiving heated liquid and distributing the heated liquid to a dissipater;

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a dissipater for receiving the heated liquid and cooling the liquid;

an output cavity for receiving the cooled liquid from the dissipater and transporting the cooled liquid to the system;

wherein the input cavity, the dissipater and the output cavity are disposed to form the self-contained heat exchange unit;

one or more heat transfer units coupled to the heat generating components for receiving cooled liquid from the heat exchange unit and generating heated liquid for transportation to the heat exchange unit; and

means for transporting cooled liquid from the heat exchange unit to the heat transfer units and for transporting heated liquid from the heat transfer units to the heat exchange unit.

54. (Amended) A liquid cooling system as set forth in any one of claims 52 [and] or 53 wherein the heat transfer units and the heat exchange unit are deployed in a single unit installable as a single unit within the electronic system.

55. (Amended) A liquid cooling system for cooling heat-generating components in an electronic system having no liquid reservoir and having a heat exchange unit, the heat exchange unit comprising:

an input cavity for receiving heated liquid and distributing the heated liquid to a dissipater in the reservoirless liquid cooling system;

a dissipater for receiving the heated liquid and cooling the liquid in the reservoirless liquid cooling system; and

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an output cavity for receiving the cooled liquid from the dissipater and transporting the cooled liquid to the reservoirless liquid cooling system.

56. (Amended) A liquid cooling system for cooling heat-generating components in an electronic system and having a self-contained heat exchange unit installable as a single unit within the electronic system, the heat exchange unit comprising:

an input cavity for receiving heated liquid and distributing the heated liquid to a dissipater;

a dissipater for receiving the heated liquid and cooling the liquid; [and]

an output cavity for receiving the cooled liquid from the dissipater and transporting the cooled liquid to the system[.]; and

wherein the input cavity, the dissipater and the output cavity are disposed to form the self-contained heat exchange unit.

57. (Amended) A liquid cooling system as set forth in any one of claims 55 [and] or 56 wherein the dissipater includes one or more liquid paths for transporting the liquid through the dissipater.

58. (Previously Presented) A liquid cooling system as set forth in claim 57 wherein said liquid paths include means for creating non-laminar flow of the liquid to enhance the transfer of heat from the liquid to the dissipater.

59. (Previously Presented) A liquid cooling system for cooling heat-generating components in an electronic system having a heat exchange unit, the heat exchange unit comprising:

a dissipater for receiving the heated liquid and cooling the liquid;

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an output cavity for receiving the cooled liquid from the dissipater and transporting the cooled liquid to the system; and

a pump disposed in the output cavity wherein the liquid is transported in response to operating the pump.

60. (Previously Presented) A liquid cooling system as set forth in claim 59, wherein the pump is a self-priming pump.

61. (Previously Presented) A liquid cooling system as set forth in claim 59 wherein the pump is disposed at the lowest possible point in the heat exchange unit.

62. (Amended) A liquid cooling system as set forth in claim 59 wherein the pump includes an impeller, the heat exchange unit the liquid further comprising:

a motor coupled to the heat exchange unit; and

a shaft coupl[ed]ing [to] the motor to the impeller means, the motor operating the impeller through the shaft.

63. (Previously Presented) A liquid cooling system as set forth in claim 62 wherein the motor is disposed on top of the heat exchange unit and away from possible contact with the liquid.

64. (Previously Presented) A liquid cooling system as set forth in claim 62 wherein the shaft is disposed through the liquid in the dissipater.

65. (Previously Presented) A liquid cooling system as set forth in claim 64 wherein no seal is necessary for the impeller.

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66. (Amended) A liquid cooling system as set forth in any one of claims 55 [and] or 56 wherein the heat exchange unit further comprises one or more fans disposed to direct air through the heat exchange unit and to dispel air from the electronic system housing.

67. (Previously Presented) The liquid cooling system as set forth in claim 66 wherein the dissipater includes fins for dissipating heat from the liquid and disposed so as to create a non-laminar flow of the air from the fans.

68. (Amended) A liquid cooling system having no reservoir and having one or more heat transfer units, the heat transfer unit[s] comprising;

a housing in the reservoirless liquid cooling system;

an inlet to the housing ;

an outlet from the housing positioned above the inlet;

means for transporting liquid coupled to the inlet and the outlet; and

wherein cooled liquid enters the housing at the inlet and heated liquid exits the housing at the outlet.

69. (Amended) A liquid cooling system having a self-contained heat exchange[r] unit installable as a single unit within a system with one or more heat-generating components and having one or more heat transfer units, the liquid cooling system comprising

an input cavity for receiving heated liquid and distributing the heated liquid to a dissipater;

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a dissipater for receiving the heated liquid and cooling the liquid;

an output cavity for receiving the cooled liquid from the dissipater and transporting the cooled liquid to the system;

wherein the input cavity, the dissipater and the output cavity are disposed to form the self-contained heat exchange unit;

a heat transfer unit housing for coupling to heat-generating components;

an inlet to the heat transfer unit housing;

an outlet from the heat transfer unit housing positioned above the inlet;

means for transporting liquid coupled to the inlet and the outlet; and

wherein cooled liquid from the self-contained heat exchange unit enters the heat transfer unit housing at the inlet and heated liquid exits the heat transfer unit housing at the outlet.

70. (Amended) The liquid cooling system in any one of claims 68 [and] or 69 for cooling heat generating components in an electronic system.

71. (Amended) The liquid cooling system of claim 70 wherein the heat transfer [system] units further comprise:

a contact coupled to the housing [means] for forming a cavity for conveying liquid, the contact capable of transporting heat from the heat generating components to the liquid thereby producing heated liquid which rises in the cavity;

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72. (Amended) The liquid cooling system in claim 55 [and 56] wherein the input cavity is positioned above the dissipater and the output cavity is positioned below the dissipater.

73. (Previously Presented) A liquid cooling system for cooling heat generating components in an electronic system comprising a liquid coolant wherein the liquid coolant is a propylene glycol base.

74. (Cancelled) The liquid cooling system of claim 73 wherein water is an additive.

75. (Amended) A method of cooling heat generating components in an electronic system having no reservoir, the method comprising the steps of:

receiving heated liquid from one or more heat transfer units at a heat exchange unit;

cooling the liquid within the heat exchange unit for transportation to the heat transfer units;

receiving cooled liquid from the heat exchange unit at the heat transfer units; [and]

heating the liquid within the heat transfer units by transferring heat from the heat generating components to the liquid for transportation to the heat exchange unit[.]; and

wherein all of the above steps are performed in the reservoirless liquid cooling system.

76. (Amended) A method of cooling heat generating components in an electronic system having a self-contained heat exchange unit installable as a single unit within the electronic system, the self-contained heat exchange unit including an input cavity for receiving heated liquid and directing the heated liquid to a dissipater which cools the heated liquid and an output cavity for receiving the cooled liquid from the dissipater and directing the cooled liquid to the electronic system, the method comprising the steps of:

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receiving heated liquid from one or more heat transfer units at [a] the self-contained heat exchange unit;

cooling the liquid within the self-contained heat exchange unit for transportation to the heat transfer units;

receiving cooled liquid from the self-contained heat exchange unit at the heat transfer units; and

heating the liquid within the heat transfer units by transferring heat from the heat generating components to the liquid for transportation to the self-contained heat exchange unit.

77. (Amended) A method of cooling heat generating components in an electronic system having no reservoir and having a heat exchange unit, the method comprising the steps of:

receiving heated liquid at an input cavity of the heat exchange unit and distributing the heated liquid to a dissipater;

cooling the liquid in the dissipater; [and]

receiving the cooled liquid from the dissipater at an output cavity for directing the cooled liquid to the system[.]; and

wherein all of the above steps are performed in the reservoirless liquid cooling system.

78. (Amended) A method of cooling heat generating components in an electronic system having a self-contained heat exchange unit installable as a single unit within the electronic system, the method comprising the steps of:

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receiving heated liquid at an input cavity of the self-contained heat exchange unit and distributing the heated liquid to a dissipater in the self-contained heat exchange unit;

cooling the liquid in the dissipater; and

receiving the cooled liquid from the dissipater at an output cavity in the self-contained heat exchange unit for directing the cooled liquid to the system.

79. (Amended) The method in any one of claims 77 [and] or 78 further including the steps of transporting heated liquid to the input cavity [means] and cooled liquid from the output cavity [means].

80. (Amended) The method of claim 79 further comprising the step of directing air flow through the heat exchange [means] unit and expelling the air out of the electronic system to maintain cooler temperatures inside the electronic system housing.

81. (Amended) A method of cooling in a liquid cooling system having no reservoir and having one or more heat transfer units coupled to heat generating components, the method comprising the steps of:

performing convective circulation in the heat transfer units of the reservoirless liquid cooling system by positioning an outlet for heated liquid above an inlet which receives cooled liquid, the liquid rising in response to the transfer of heat from the heat generating components to the liquid in the heat transfer units.

82. (Amended) A method of cooling in a liquid cooling system having a self-contained heat exchange unit installable as a single unit within a system with one or more heat-generating components, the self-contained heat exchange unit including an input cavity for receiving heated liquid and directing the heated liquid to a dissipater which cools the heated liquid and an output

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cavity for receiving the cooled liquid from the dissipater and directing the cooled liquid to the system, and having one or more heat transfer units coupled to the heat generating components, the method comprising the steps of:

performing convective circulation in the heat transfer units of the liquid cooling system having the self-contained heat exchange unit by positioning an outlet for heated liquid from the heat transfer units above an inlet of the heat transfer units which receives cooled liquid, the liquid rising in response to the transfer of heat from the heat generating components to the liquid in the heat transfer units.

83. (Amended) The method in any one of claims 81 [and] or 82 for cooling heat generating components in an electronic system.

84. (Amended) A method of cooling in any one of claims 77 [and] or 78 comprising the additional step of performing convective circulation by:

positioning the input cavity [means] above the dissipater; [means;] and

positioning the output cavity [means] below the dissipater. [means.]

85. (Amended) A method of cooling heat generating components in an electronic system with a liquid cooling system having no reservoir, the method comprising the steps of:

performing forced circulation of a liquid in the reservoirless liquid cooling system by a pump; and

performing convective circulation of the liquid in the reservoirless liquid cooling system by disposing inlets and outlets for cooler liquid below inlets and outlets for heated liquid.

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86. (Amended) A method of cooling heat generating components in an electronic system with a liquid cooling system having a self-contained heat exchange unit installable as a single unit within the electronic system, the self-contained heat exchange unit including an input cavity for receiving heated liquid and directing the heated liquid to a dissipater which cools the heated liquid and an output cavity for receiving the cooled liquid from the dissipater and directing the cooled liquid to the electronic system, the method comprising the steps of:

performing forced circulation of [a] the liquid in the liquid cooling system having the self-contained heat exchange unit by a pump; and

performing convective circulation of the liquid in the liquid cooling system having the self-contained heat exchange unit by disposing inlets and outlets for cooler liquid below inlets and outlets for heated liquid.

87. (Amended) The method in any one of claims 85 [and] or 86 further including the step of dissipating heat generated by the heat generating components in response to the forced circulation and convective circulation.

88. (Amended) The method in any one of claims 85 [and] or 86 wherein the heat generating components are cooled after power is shut down in the system.

89. (Amended) The method in any one of claims 85 [and] or 86 for saving power consumed in the system.

90. (Previously Presented) A liquid cooling method for heat generating components in an electronic system comprising the step of using propylene glycol as the base for the liquid coolant.

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91. (Cancelled) The liquid cooling method of claim 90 further comprising the step of adding water as an additive to the liquid coolant.

92. (Amended) A motherboard further comprising the liquid cooling system of any one of those in claims 52, 53, 55, 56, 59, 68, 69, 72, [and] 73[.]or 98.

93. (Amended) A computer further comprising the liquid cooling system of any one of those in claims 52, 53, 55, 56, 59, 68, 69, 72, [and] 73[.]or 98.

94 (Amended) A telecommunications system further comprising the liquid cooling system of any one of those in claims 52, 53, 55, 56, 59, 68, 69, 72, [and] 73[.]or 98..

95. (Amended) A cellular telephone further comprising the liquid cooling system of any one of those in claims 52, 53, 55, 56, 59, 68, 69, 72, [and] 73[.]or 98..

96. (Amended) A device including a processor further comprising the liquid cooling system of any one of those in claims 52, 53, 55, 56, 59, 68, 69, 72, [and] 73[.]or 98..

97. (Amended) A optical device including further comprising the liquid cooling system of any one of those in claims 52, 53, 55, 56, 59, 68, 69, 72, [and] 73[.]or 98.

98.(New) The liquid cooling system in claim 56 wherein the input cavity is positioned above the dissipater and the output cavity is positioned below the dissipater.

99. (New) The liquid cooling system in any one of claims 55 or 56 further including a pump disposed within the output cavity of the self-contained heat exchange unit.